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A 5TH GENERATION FIGHTER FOR BELGIUM:

LUXURY OR NECESSITY?

by

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Biography

Lieutenant Colonel Patrik De Groot entered the Belgian Air Force in 1993. After completing the F-16 conversion program at Tucson (AZ), he started his operational career in 1997 at the 10th Fighter Bomber Wing in Kleine Brogel (BEL). Within the F-16 Unit, he deployed 6 times to Italy in support of IFOR and KFOR missions over Bosnia and Kosovo. In 2007 he transitioned to the 15th Tactical Airlift Wing were he completed his C-130H conversion. After successfully completing the Majors Course, he returned to the 15th Wing as Squadron Commander of the Transport Conversion Unit. During his stay in the 15th Wing he qualified as Aircraft Commander and led 6 Belgian Detachments as detachment commander in support of UN mission MONUSCO in central Africa. In 2012 Major Patrik De Groot transitioned to the Belgian Air Force Headquarters in Brussels, where he was responsible for the evaluation of national and NATO conventional and nuclear flying units. Lieutenant Colonel Patrik De Groot has logged a total of 3900 hours of which 1700 hours on the F-16 and 1500 on C-130H. He is currently a student at the Air War College at Maxwell Air Force Base, Alabama.

Abstract

The Belgian Government has decided to replace the F-16. Although political factors like international cooperation, economic return on investment and life cycle cost are seen as driving decision points[1], it also poses the great challenge to correctly identify the technological requirements for a future fighter platform which has to deliver responsive and effective airpower in the anticipated environment of 2035. We face a moment in time where these choices will likely define our relevance in future operations. How ambitious and relevant does Belgium want to be in the volatile, uncertain, complex and ambiguous future battle space? What will be the mission of the Belgian Air Component in 2035? How will it conduct its mission as part of a joint, interagency, or multinational force, or independently in support of national objectives? Therefore, do we require investing in top notch technology? Is a 5th generation fighter for Belgium a necessity or a luxury? Through the analyses of the future security and operating environment and the assessment of the capability requirements, this paper recommends Belgium invest in this technology.

Introduction

Although neither Belgium, nor Europe is facing a direct military threat against its territory, recent Russian assertive and aggressive posturing is of concern to the NATO alliance. Since the Russia-Ukraine crisis, deterrence is making a comeback and has hastened its resurrection.[2] The credibility of NATO Article 5 demands, besides the American nuclear umbrella, a real European conventional intervention capacity. A credible, modern military and expeditionary capacity underpins the European democracy and has a preventive effect.[3] If Belgium wants to maintain its credibility and reputation as an effective and efficient NATO Air Power partner, it will have to invest in a 5th generation fighter (Annex A) and therefore deliberately choose technical superior quality above quantity. Network enabled operations, sensor fusing, low observable characteristics, cyber and ISR capabilities outline future Air Operations. However, prevailing in this future environment also requires holistic approaches using concepts of operations that integrate varied capabilities, capacities and tactics to create Allied or coalition advantage.[4] Obviously, the technological choice to be made will be framed by budgetary, industrial, military-doctrinal, political and ideological parameters. The aim of this paper is to assist in making judicious investment choices, and I will mainly focus on the technological requirements which make a fighter relevant in the anticipated future operational environment of 2035. I will start by exploring the future security environment of 2035, viewed through the lens of global security actors and underpinned by national strategic vision. Then I will analyze the 2035 operating environment and assess how this might drive future Belgian Air Components capability requirements. Finally, I will conclude with an investment recommendation.

The Future Security Environment of 2035

Introduction

It is anticipated that globalization will continue to contribute to state weakness and failure. Issues related to the environment, identity, disparity, health and welfare will undermine stability where it is most needed. Peer versus peer conflict will remain less likely than smaller inter -and intra-state conflicts between both state and non-state actors.[5] This chapter will summarize future global security challenge views of the most relevant security organizations interacting with Belgian Defense. These organizations will undoubtedly put political pressure on the Belgian government to take steps and actions needed to contribute credible, relevant forces to add to the will of the international community whenever required.

NATO

Currently, NATO is at a historical turning point. The world that was built after the end of the Cold War is being challenged in different aspects and directions. Key environmental and resource constraints including health risks, climate change, water scarcity and increasing energy needs will further shape the future security environment in areas of concern to NATO. These have the potential to significantly affect NATO planning and operations.[6] In every hemisphere, NATO is confronted with a variety of security challenges. The melting Artic ice pack opens potential trade routes to the North, 40% shorter than current established routes. However, these new trade routes may cause additional security problems. To the East, Russia's aggression against Ukraine may signal an attempt to rewrite international rules and recreate its sphere of influence. Russia demonstrated that force is again on the table to change borders. At the same time, to the South, we observe states or extremist groups using violence to assert power. Overall,

we see threats, old and new, from piracy to terrorism to cyber-attacks. Based on these increased threats, NATO needs to prepare for future interventions.[7] According to the US Air Force Future Operating Concept, globalization and the increase of human population will be the main causes of friction and conflict in the future. In the year 2035, the majority of the people will live in urban environments, cities or megacities. Therefore, an increasing number of future military operations will take place in these environments. Finally, proliferation of weapons of mass destruction and empowering technologies remain a major concern to NATO. Air-delivered nuclear weapons and their delivery platforms remain well-suited for the complex, dynamic political/military environment of 2035. The act of placing forces on alert or deploying to forward operating locations provides a visible indication to adversaries of U.S. commitment to its alliance partners and to international stability. Furthermore, air-delivered nuclear weapons and ICBMs continue to ensure first strike capability even in the face of nuclear proliferation.[8] Deterrence - based on an appropriate mix of nuclear and conventional capabilities - will remain a core element of the NATO strategy. In conclusion, as long as nuclear weapons exist, NATO will remain a nuclear alliance.[9]

The European Union

In a rapidly changing world, the EU is faced with security challenges both in its immediate neighborhood and further afield. The Common Security and Defence Policy (CSDP) enables the Union to take a leading role in peace-keeping operations, conflict prevention and in the strengthening of international security. The CSDP is an integral part of the EU's comprehensive approach towards crisis management, drawing on civilian and military assets and in a time of limited resources, Europe will need to do better with less. The CSDP allows EU

Member States to pool their resources and build stronger defense capabilities to act rapidly and effectively.[10] Both strategy and capability developments for cyber, energy security, maritime security, space, and CBRN will require constant effort and new approaches. Interoperability and even interdependency becomes a key concept of operations in a future with leaner defense capabilities. In 2035, cyber security will be in demand in virtually all dimensions of societal life. Continuous updating of vulnerability assessments (a race between offensive and protective measures and technologies) will be pivotal. To guarantee a secure cyber environment, technological innovation is a crucial prerequisite for EU action in this domain.[11] Furthermore, the EU acknowledges the fact that threats posed by predatory and unpredictable neighboring regional actors, violent extremism, ethnic strife and increasing lethality and risk of intrusion by terrorist and criminal organizations pose a capital risk upon the EU.

United Nations (UN) and Organization for Security and Cooperation in Europe (OSCE)

Both organizations play a crucial role as overarching bodies that govern or provide frameworks for security operations. However, they do not influence directly the combat capability requirements needed to effectively execute these operations. Hence, their vision of the future has not been analyzed.

National Analyses of the Security Environment 2035

The security environment, as seen through a national lens, indicates that internal and external national security is closely related to global security issues. Maritime transport, energy supply, information management and cyberspace management are essential elements which guarantee the freedom, security and prosperity of the country and its people. As the world

becomes more and more complex, international security is put under increased pressure because of the fragmentation of both shifting centers of power and power vacuums. Belgium finds itself amid a multitude of security problems which flow from the unstable European periphery. To counter this, it is necessary that Belgian defense contributes to NATO, to the UN's global stabilization efforts and to a comprehensive European security and defense effort.[12] In order to show solidarity and to remain relevant, Belgium will need to be able to adapt and respond to the 2035 global security prognoses.

Belgian Defense policy is subordinate and subject to the Belgian Government foreign policy. The foreign policy takes into account the relative size of the country and its position in the geostrategic environment and organizations it is part of, namely: EU, NATO, OSCE and UN. Solidarity plays an important role in Belgium's foreign policy. Belgium has contributed and must continue to contribute in many multinational missions within these organizations. According to Minister of Defense Steven Vandeput, Belgium desires to stay actively engaged in future multinational operations and the security decision process.[13] After the retirement of the F-16, Belgium wants to maintain a credible multirole platform.[14] Therefore, it will need to invest in a credible and relevant successor. This combat capacity should be able to guarantee Quick Reaction Alert (QRA) and air policing tasks. Furthermore, the Belgian Air Component needs to be able to continuously support operations with 4 to 6 aircraft where it can engage in missions like ISR, Air Interdiction, Close Air Support, Offensive Counter Air or other missions in support of national deployments.[15] With this level of ambition, a more global concept of Pooling and Sharing remains equally important. In an ideal European Defense concept, defense assets should be utilized in an economically efficient way in order to optimize usage of these scarce assets.

Belgian F-16's have conducted operations in Bosnia, Kosovo, Afghanistan, Libya and Iraq without any loss of asset or life. Such operations ranged from low to high intensity and eliminated the option to use ground troops. Whereas the use of ground combat troops in future conflicts becomes more and more unlikely, the use of combat aviation becomes even more important. When planning to be engaged in NATO, EU or UN operations, Belgium would rather trade combat air power in lieu of "boots on the ground". Therefore, the evolution and the changing character of military operations underpin the importance of combat aviation in Belgian Defense policy.[16] Today, the Belgian Air Component is the only Belgian Defense component which can engage in full spectrum military operations, utilizing minimal ground support and accounting for all risks. In addition, it is capable of generating maximum political effects within current budgetary constraints and political guidance. If Belgian Defense wants to achieve the same effects in 2035, it will require investing in multirole platforms suited to the 2035 operational environment.

An adequate investment in a future fighter means that it will able to support future operations with partner nations in addition to a robust ability to protect the homeland and our national Defense Forces. The efficiency and effectiveness of 4th generation weapon platforms was measured in terms of speed, range, precision, reliability and interoperability. Taking future warfare predictions into account, additional factors like low observable characteristics, network enabling capability efficiency, presence of advanced multi- spectral sensors and sensor fusing capability must be evaluated now to truly determine overall aircraft efficiency and effectiveness. The next generation aircraft will be more expensive. Therefore, national economic policies will be an important part of the negotiation and decision process. However, fewer aircraft will be needed to accomplish the same missions. Last but not least, Belgium is characterized by its

complex societal system with a multitude of communitarian, linguistic and socio-historical nuances. Belgium features two combat aircraft bases that both have a huge economic impact on their local region. The closing of one of both bases, as a result of a reduced number of newly acquired combat aircraft, is therefore considered unacceptable. However, although the number of available next generation aircraft probably will be reduced, support requirements will remain the same or might even increase.[17]

The question of whether Belgium needs to remain engaged in nuclear burden sharing can only be answered after consensus within the collective environment of political and NATO members' leadership. Global security issues like, for example, the recent Russia-Ukraine crisis, the modernization of the Russian nuclear weapon arsenal and the uncertainties of the Iranian nuclear ambition level drive a conservative posture with regard to diminishing the nuclear capacity within NATO. NATO's nuclear level of ambition will have implications for its member countries and will be a decisive factor for the successor to the F-16.

Conclusion

NATO and the EU cover an area of interest of almost a quarter of the globe in the northern hemisphere. Furthermore, Belgium has regions of national interest across Africa and other parts of the globe. In this context, our Defense strategy must enable us to contend with state or non-state actors, transnational actors, declining states or the dynamic web of terrorism. Therefore, the Air Component must be able to perform a broad range of tasks and operate in all engagement spaces (land, air, maritime, space and cyber). In sum, future operations will occur in the physical, moral and information domains - at home and abroad - and in complex or extreme environments. However, these operations will likely be conducted primarily in urban and littoral

regions, utilizing both conventional and asymmetric means. The Belgian Air Component will be expected to function in this future security environment; therefore, it has to anticipate these needs and mitigate expected risks. Failure to do so will put both national and coalition future sovereignty and future security at risk and diminish its ability to remain a viable and relevant actor on the world stage.[18]

The Future Operating Environment of 2035

Introduction

Armed with an appreciation of the future security environment, the future operating environment section will describe in greater detail the concepts and broad designs that will shape the future Belgian Air Component. This understanding will enable an Air Force to operate effectively as it carries out its core missions by means of fighter operations in terms of protecting and projecting Coalition and national interests at home and abroad.[19]

Operation Agility

There is only one way for Belgian Defense to position itself for an uncertain future: that is to be agile. This agility must be institutionalized at all levels from the organization to the individual. It will require greater investments in long lead, expensive programs in terms of material, training and education.[20] An operationally agile Air Component will have the ability to rapidly generate – and shift among – multiple solutions for a given challenge. An agile Air Component will possess a variety of options for a given challenge and, when the enemy develops a counter, will be able to adapt by flexing quickly to a different solution. The ability to generate multiple options or solutions for a given challenge will provide the Air Component with the agility at the operational level of war necessary to engage adversaries effectively. For an Air Force to prevail in 2035, it will need to apply the facets of agility, i.e., flexibility, speed, coordination, and balance (Annex B).

The Nature of Future Warfare

The exact nature of future warfare will be forever difficult to define. Although traditional challenges like state versus state conflicts are unlikely, they cannot be totally ruled out and nations and allies need to take steps to respond to it should it arise. Irregular challenges will most likely be the most prevalent form of conflict out to 2035. Such conflicts will typically take place across the developing world where adversaries are rarely composed of regular forces and which do not always rely on sophisticated military technologies. Nevertheless, adversaries will continue to plan and execute attacks to shock populations and cause maximum casualties. Finally, disruptive challenges will gain importance in future warfare. As with other forms of future conflict, disruptive challenges to national or coalition sovereignty will come in many forms like piracy, computer network attack, natural disaster etc.[21] In order to tackle these challenges, four main domains are identified in which future combat aircraft should excel in order to be effective and efficient.

1. Multi-Domain Command and Control. The Air Component is a service whose people and processes depend greatly on collecting and analyzing data; therefore, information and its protection will become paramount to a future Air Force. The imperative to command and control personnel in the field is fundamental to military operations. Likewise, there is an enduring, ever-present need to tie ways and means to ends to achieve the desired effects, regardless of technology or context. Accordingly, the fundamentally linear approach codified in the legacy air tasking cycle—plan, task, execute, and assess—is indisputable. By 2035, what has changed is the technology and processes around which Air Forces organize, train, and equip forces to ensure the ability to conduct effective multi-domain operations. At the operational level, Air Force C2 organizes around the multi-domain operations center (MDOC), which

provides the tools necessary to exercise dynamic command and control. The MDOC is the focal point for Air Force efforts to plan, task, execute, and assess missions as the Air Operations Center (AOC) did in the past. Serving as the air, space, and cyberspace operational headquarters, the MDOC contains the essential command elements and authorities to direct multi-domain operations. The MDOC will provide an Air Force with the ability to plan, conduct, and assess integrated multi domain operations.[22]

2. Adaptive Domain Control. The Adaptive Domain Control mission includes the ability to operate in and across air, space, and cyberspace to achieve varying levels of domain control or superiority over adversaries seeking to exploit all means to disrupt friendly operations. Domain superiority is that degree of dominance that permits the conduct of friendly operations at a given time and place without prohibitive interference by an adversary. Space and cyberspace capabilities have become as integral as air capabilities to the Air Force's approach to integrated multi-domain operations, which exploits opportunities and protects vulnerabilities.[23]

3. Global Integrated Intelligence, Surveillance, and Reconnaissance (GIISR). ISR plays a fundamental and constantly-increasing role in how the joint force maintains situational awareness, conducts and assesses operations, and employs force against adversaries. GIISR continues to enable current and future operations through the cross-domain synchronization and integration of: planning and operation of ISR assets; collection using near-ubiquitous sensors; and processing, exploitation and dissemination (PED) of finished intelligence. GIISR also includes the integration of collection and analysis, and evolved production capabilities across the globe. ISR is conducted in, from, and through all domains, in all phases of operations, and in complex operating environments ranging from permissive to highly-contested. Simply put, ISR is the foundation upon which every joint, interagency, and coalition operation achieves success.[24]

4. Global Precision Strike. In order to maximize operational agility against advanced adversaries, most strike missions include closely integrated operations and effects in more than one domain. Precision strike effects are well-timed, synchronized, immediately assessable, and scalable to minimize provocation and avoid unintentional escalation. [25] Precision strike will not be based on a single technology, system or capability. Rather it reflects a number of key attributes like for example the ability to perform near perfect weapons delivery through extremely accurate navigation and the ability to circumvent or, as necessary defeat, hostile air defense and surveillance systems. A greater percentage of target identification and tracking will be required in a dynamic planning environment not only en-route but during combat. Therefore, access to real-time highly accurate ISR information will be required. Network empowered strike platforms equipped with sophisticated sensors and communications suites will enable dynamic targeting and retargeting based on a continually changing common operating picture.[26]

Conclusion

The Future Security Environment attempts to explain potential future threats and attempts to define how the Air Component will have to respond and function within it. The Future Operating Environment assessment attempts to draw the lines of concepts and broad designs that will shape a future Air Force. Further analyzed in the context of the Air Component's functions, the Future Security Environment and Future Operational Environment have together revealed a broad portfolio of Future Capability Requirements that will be needed to address the most serious risks presented to national sovereignty, security and national interests both at home and abroad in 2035. The next section examines the future capability requirements in greater detail and forecasts what an Air Force of 2035 will require to be an effective instrument of national strategy.

Future Capability Requirements

Introduction

In this section, the technological evolution is examined for different relevant areas pertaining to combat systems. This examination will identify areas in which Belgian Defense will need to invest in order to make sure it can continue to provide capable and relevant systems in light of the anticipated future strategic and operational environment of 2035.[27] Furthermore, it will provide guidance to stay in line with the upgrades and modernizations done by partner nations to conduct its core missions as part of a joint, interagency, or multinational force, or independently in support of national objectives.

Evolution in Concept of Operations

In the past, the focus of warfare was predominantly on managing the physical elements of a conflict, i.e., planes in the sky, satellites in space, troops on the ground, amphibious elements and ships at sea. In the future, desired effects will increasingly be attained through the interaction of multiple systems, each one sharing information and empowering one-another for a common purpose. This phenomenon is not restricted to an individual technology or system, nor is it isolated to a specific Service, domain or task. It is a concept that can loosely be envisioned as a "Combat Cloud"- an operating paradigm where the preeminent combat systems of the past become elements in a holistic enterprise where information, data management systems, and command and control practices become the core mission priorities. Network-centric, interdependent, and functionally integrated operations are keys to future military success. It means taking the next step in shifting away from a structure of segregated land, air or sea warfare to integrated operations based on the four functions of ISR, strike, maneuver, and sustainment.

Modern sensor-shooter aircraft enable the kind of interdependency required for future air operations. They are key elements in enabling allied forces to work in an interdependent manner throughout the extended battle space to deliver the effects or outcomes that are necessary for deterrence as well as war fighting dominance. Current fifth generation fighters have already demonstrated the capability to provide multi-tasking, including command and control for an engaged force and the ability to provide for C2 in the extended battle space. These fifth generation fighters do not only replace “old aircraft” but are part of the C2 dynamics crucial to an ability to fight and prevail in challenging battle space. These fifth generation aircraft will drive the concept of future operations. [28]

Evolution in Weapon Technology

The advanced weapons of 2035 will be intelligent, accurate and lethal devices. The key to success will be keeping up with rapidly developing technologies and applications. The evolution in standoff, penetrating strike and swarm and saturation technology will mitigate the risk for future air dominance platforms. Future CAS, Air Interdiction, Cyberspace and cyber warfare missions will be performed in a volatile, unknown, complex and ambiguous environment and will rely heavily on multi-sensor fused data through the use of an agile combat platform. Branched to a combat cloud, manned and unmanned systems will be provided with a comprehensive battle space picture to deliver an effective and tailored response. As sensors evolve to detect current stealth aircraft, stealth technology to shield aerial platforms from detection will likewise evolve. Refer to Annex C for details on technological evolution in each domain.

Advanced weapons in 2035 will include fewer of the traditional "dumb" weapons and a greater number of sophisticated tools such as Direct Energy Weapons (DEWs), highly directional electromagnetic pulse (EMP) weapons and intelligent Distributed Aperture System (DAS). Appropriate precision munitions will enable the Air Component to conduct military operations with the appropriate force, causing minimum collateral damage and thus avoiding public criticism. In fact, the ability to deliver kinetic power with surgical precision (i.e., absolute minimal collateral damage possible) will become the baseline standard for every modern military Air Force in the West. Public opinion will dictate that every military mission be capable of delivering kinetic and non-kinetic precision effects. The use of imprecise kinetic weapons that cause collateral damage will increasingly become an impediment to any future mission. In order to optimize the continuous use of advanced weapon systems, a strategically managed support system throughout their lifecycles will be required.

The evolution in fighter aircraft technology has created a significant technology gap between 4th+ and 5th generation fighter aircraft. Where current 4th+ generation fighters are suitable for today's tactical need they are less suitable for tomorrow's and only bridge a gap to the next generation. Current combined generation fleet air forces use the 5th generation fighter to increase battlefield performance of the 4th + generation fighter.[29] Without this support, the 4th + generation fighter will soon be less relevant and, while the 5th generation fighter will gain importance, the 4th + generation fighter will ultimately become an orphan generation after the closure of production lines.[30] Current 5th generation fighter aircraft are a step beyond the 4th+ generation multi-role platform and their mission is based on delivering mission simultaneity. From an operator perspective, the pilot will be dealing with one aspect of the mission while the aircraft will simultaneously be using its plethora of sensors to do something else. Unbeknownst

to the pilot, the aircraft may be finding the most critical element pertinent to winning the whole war.[31] We need to understand the nature and characteristics of the future security and operating environment as well as the implications for future armed conflict in the air and beyond. We need to think beyond the constraints that traditional military culture imposes on new technology. For example, 5th generation fighters are termed fighters but technologically, they are not just fighters – they are F-, A-, B-, E-, EA, RC, AWACS etc. These new aircraft are actually more properly described as a flying sensor-shooter that will allow us to conduct information age warfare inside contested battle space whenever we desire – if we fully exploit their non-traditional capabilities to the degree that those capabilities become accepted as the new traditional. [32] As such, a 5th generation fighter will be the cornerstone of an agile and adaptive air force which is fully immersed in the information age and can in fact operate jointly.[33]

Air capabilities will become increasingly dependent on networks (many hosted by space bearers) for the rapid and effective transmission of data and information. This offers a potentially battle-winning edge, but also represents a vulnerability that must be defended, as the networks may be subject to both intentional and inadvertent disruption. A better understanding of dependencies, which are often transparent to the user, must be achieved, so that malicious or environmental degradation can be mitigated. We must also understand how to affect our adversaries' networks, including knowledge of the second order effects that may result from successful disruption operations. Belgium is investing in cyber capabilities on a cross-government basis, but Defense must do more. While the lead for military cyber operations is at a joint level, the air component must understand its own dependencies, requirements and vulnerabilities. This will then enable us to determine ownership and the division of responsibilities; not least for coordinating the offensive cyber operations that will play an

important part in future air campaigns. However, this is not just a cyber-issue. Electronic and navigation warfare, as well as signals intelligence, will also play an important defensive and offensive role in an increasingly networked operating environment.[34]

Conclusion

The future operating environment will offer significant challenges to both air power and the air forces that project it. While some of the ideas presented here may seem fanciful to us today, we must keep in mind that air forces exist now because the visionaries of yesterday imagined a fanciful future where air power would have a prominent place. Today, that vision is not only realized, but it also presents new opportunities as well as new risks. As such, we must continue to ask hard questions of the future of air power, even as we seek to create our own place within it. Furthermore, we must employ these concepts and doctrine in the development of future air requirements and capabilities that will ensure the Air Force's effectiveness well into the future.[35]

The shifting balance of power means that reduced research, development and procurement budgets relative to potential adversaries will progressively erode the technology gap between 'the West and the rest' from 2020 onwards. While there is little likelihood of direct conflict between Europe and states such as Russia and China, rapid diffusion of military technologies developed by these nations can be exported to state and non-state actors elsewhere. Consequently, NATO or other Allied forces may not be able to assume either a quantitative or qualitative advantage over many potential adversaries. Likely opponents may also be more agile as adopters of new technology. They may be less fettered by the need for transparency and the resulting bureaucracy inherent in procurement processes in western democracies. They may also

be free of many of the legal and ethical concerns that constrain novel weapon concepts in the West. Some potential adversaries are likely to gain access to nuclear, biological, radiation or chemical weapons within the concept timeframe. Lastly, they may also have few inhibitions about their employment.[36] If Belgium wants to stay engaged in future multinational operations, it will need to be able to perform a broad range of tasks and operate in all engagement spaces adapting and responding to the 2035 global security prognoses.

Traditionally, the process behind weapon system acquisition considers and analyzes mainly the political factors that shape this decision, for example: standpoint of international partners, multinational cooperation, economic return on investment, life cycle cost, etc. Vague concepts like national interest and global threat are difficult to understand, and more difficult to tie directly to resource decisions. Through the analyses of the future security and operating environment and the resulting capability requirements, this paper attempted to quantify these vague future threat abstractions and focus on end user hardware requirements which will allow the Belgian Air Component to be relevant in the future operating environment of 2035 and beyond. Ultimately, a 5th generation aircraft allows the pilot to maintain decision superiority over an adversary and is technologically the most suitable platform to mitigate mission risk. This provides greater chances of survivability, which when combined with effective lethality, assures battle space dominance.[37] Politically, having a 5th generation asset will guarantee a seat and vote around the table and can act as a medium of exchange when planning to be engaged in operations for many years to come. Therefore, this paper recommends Belgium to invest in this technology in order to guarantee the relevance of Belgian Defense and more specifically the Belgian Air Component in the future operating environment of 2035 and beyond. In short, a fifth generation fighter for Belgium is a necessity more than it is luxury!

Annex A

Fighter Generations

The notion of aircraft generations, a term that applies to only jet rather than propeller driven fighter aircraft, appeared in the 1990s and attempted to make sense of the leap-frogging improvements in performance to jet fighter aircraft brought about through major advances in aircraft design, avionics, and weapon systems. While the rationale that constitutes a generational shift is debatable, a generational shift in jet fighter aircraft occurs when a technological innovation cannot be incorporated into an existing aircraft through upgrades and retrospective fit-outs. The aircraft generation definitions below result from online research and industry inputs and can be referred to in order to frame the thesis. [38] In order to stay coherent with the received title and tasking I will use the term 5^{th} generation instead of next generation.

4^{th} generation fighter: Through the 1970s and 80s, the trend of improvement in avionics such as head-up displays and optimized aerodynamic design continued with the development of ‘fly by wire’ fighters. Most fighters of this generation had the ability to both switch and swing roles between air-to-air and air-to-ground, as opposed to the previous role-dedicated aircraft. This, in turn, blurred the distinction between control of the air and strike missions.

4^{th} + generation fighter: The concept of having a half generation increment stemmed from a forced reduction in military spending, which resulted in a restriction in aircraft development. It became more cost-effective to add ‘stealth’, radar absorbent materials, thrust vector controlled engines, greater weapons carriage capacity and to extend the range of fourth

generation fighters, such as the Hornet, Eagle and Flanker, than to design new aircraft. The addition of an Active Electronically Scanned Array (AESA) radar was a significant enough game-changing combat capability for these redesigned fighters to be deemed a generation of their own, hence the 4.5 generation rating. Advances in computer technology and data links also allowed 4.5 generation fighters to be integrated into a network-centric battle space where fighter aircraft have much greater scope to conduct multi-role missions. As an example, the AESA radar allows fighter aircraft to perform a limited Airborne Early Warning and Control function.

5th generation fighter: A quantum improvement in the fighter's lethality and survivability has been a qualifying requirement to achieve generational change, and the fifth generation fighters personify these traits. The advances over earlier generational fighters include nose-to-tail low observable or stealth technologies as part of the aircraft's design that make it almost impossible for even other generation five fighters to detect them; improved situational awareness through having multi-spectral sensors located across all aspects of the airframe which allows the pilot to 'look' through the airframe of the aircraft without having to maneuver the fighter to obtain a 360 degree picture, which in turn, enhances the aircraft's ability to use its suite of weapons to engage and neutralize an adversary without the adversary even being aware of the threat. These aircraft are also 'born' networked which allows them to receive, share and store information to enhance the battle space picture. Fifth generation fighter capabilities are largely defined by their software, and it will be the ongoing development of their software that will ensure they maintain their edge against evolving threats.

Annex B

Flexibility

Flexibility describes the ability to move without restriction across a range of motion that is bounded by limits in distance and direction. It is the ability to flex across the range of options that an Air Force or a coalition provides. Flexibility in operational agility manifests as integrated Multi-Domain Operations. By 2035, the meaning of integrated multi-domain operations will encompass full interoperability among air, space, and cyberspace capabilities so that the combined effect is greater than the sum of the contributed parts without being limited by rigid interdependence.

Speed

Speed in operational agility manifests as Superior Decision Speed. Air, Space, and cyberspace ISR assets will share information seamlessly and contribute to a Common Operating Picture (COP). This construct will balance speed with accuracy to deliver the ability to make risk-appropriate actionable decisions quickly. Together, these elements will increase the speed and quality of decision-making to allow superior responsiveness.

Coordination

Coordination in operational agility manifests as Dynamic Command and Control. By 2035, enhanced battle space awareness, improved planning and assessment, and organizational flexibility will better enable elements to self-synchronize and adapt to fulfill the commanders' intent. Operationally agile forces will defeat future enemy threats by fighting in a highly coordinated manner utilizing the principle of mission command.

Balance

Balance in operational agility manifests as a Balance Capabilities Mix. The future Air Force will retain tailored numbers of high-end assets to operate against adversaries that pose advanced threats to joint/multinational force efforts in any domain. To conduct follow-on sustained operations, or a sustained irregular warfare effort in a permissive environment, Air Forces primarily will use lower-cost/lower-capability assets, efficiently expending resources to achieve joint force commander (JFC) objectives while relying on partner nations. Interoperability among Air Forces will provide opportunities for partners to contribute according to their strengths.[39]

Annex C

Evolution in Standoff

Standoff entails multi-domain coordination to acquire targeting data to feed standoff platforms during weapons employment. This minimizes threat exposure, but is heavily dependent on space/cyberspace to find, fix, and track enemy targets. Therefore, standoff's cornerstone concept is using off-board sensors to cue multiple weapons against fixed target arrays. Space access, bandwidth capability and cyber security are major requirements.

From the systems requirement tier, the weapon's power source, material, guidance, range, speed and accuracy are all important planning considerations. These need to enable fly-out ranges of several hundred miles. The material needs to possess stealth qualities, have electronic warfare attributes or receive cyber-attack support to decrease, delay or deny detection during fly-out. Guidance and accuracy must ensure the weapon can navigate and hit within acceptable distances to achieve desired effects and minimize collateral damage. Overall, weapon systems requirements are the highest priority in future concept of operations. Ideally, hyper-sonic weapons would increase enemy targeting difficulties while ensuring high weapon survival rates.

In the acquisition requirement tier, weapon reliability and survivability are the drivers. Anti-jam, inertially-aided weapons with self-terminal guidance could solve this challenge. In addition, weapons should be shielded from electro-magnetic pulses and direct energy weapons. Therefore, affordability needs to be balanced with the overall weapon capability. In summary, standoff succeeds with unimpeded space/cyberspace access and networked command/intelligence support along with weapons able to survive to their intended targets.[40]

Penetrating Strike

Penetrating strike entails using air dominance platforms to enter anti-access/area denial battle space and employ self-targeted weapons. Threat exposure is high, so strike platforms need advanced technologies to aid in defending against enemy defense networks. Therefore, penetrating strike's cornerstone concept is self-targeting against fixed, mobile, and hardened arrays.

From the operations requirement tier, command network, space and cyber-attacks support strike platforms, but these platforms must survive/counter autonomous threats. Strike platforms require significant technological upgrades to counter bi-static radars and advanced surface-to-air missiles. Sensors and weapons need to counter laser defenses long enough to successfully guide weapons to their targets. Limited platform numbers equals lower available sorties which, in turn, increases the time required to complete decisive combat operations. Overall, these low density, high demand strike platforms can be single points of failure without proper design capabilities.

The systems requirement tier hinges on technological advances that must outpace air defense network capabilities. Platform materials need to maximize cloaking capabilities in the radio frequency, infrared and electro-optical spectrums. Metamaterials could provide this capability. Weapon propulsion, range and speed are not as critical as in the standoff concept of operations since platforms deliver them close to the target. However, weapon guidance and accuracy must counter jamming and possess the same characteristics as weapons in the standoff concept of operations.

Swarm and Saturation

Swarm and saturation combines manned stealth platforms, high/low tech unmanned air systems and legacy strike platforms to overwhelm air defense networks. Some platforms penetrate and employ onboard weapons/decoys while others launch standoff weapons/decoys to achieve desired effects. Threat exposure is medium based on each platform's usage and penetration depth. Unmanned air systems penetrate/saturate air defenses while deploying swarming assets (decoys/weapons). Therefore, swarm and saturation's cornerstone concept is to overwhelm defense networks with the full spectrum of assets against fixed, mobile and hardened target arrays.

The operations requirement tier has both high and low tech considerations. The command network requirement for legacy platforms and unmanned air systems is similar to the standoff CONOPS. Swarming platforms like micro air vehicles or saturation platforms like the X-47 could perform self-targeting functions.[35] These sensors and weapons could be reusable or disposable dependent on use. Overall, operations require large inventories of existing legacy systems and advanced technologies all synchronized through a secure command network. The systems requirement tier is complex due to varied technology levels in the operations tier. A resilient command network with cyber defense is crucial to asset synchronization. B-2s and penetrating unmanned air systems have similar material requirements as in the penetrating strike CONOPS. However, while stealth strike systems may require upgrades, legacy platforms would use existing capabilities. Therefore, the number and type of assets will drive the overall level and cost of technology upgrade.

The acquisition requirement tier includes considerations from the standoff and penetrating strike CONOPS. Re-usable swarming and saturation assets will require costly

upgrades for survival versus disposable platforms. Thus, affordability will drive force structure. Reliability and survivability only pertain to re-usable assets which make this feasible. In summary, swarm and saturation succeeds when advanced technologies and legacy systems overwhelm an air defense network long enough for lethal strikes to erode its capability.

Evolution in CAS

Urban areas will remain an attractive operating environment to adversaries seeking to offset precision strike capabilities. Allied forces become more and more sensitive to collateral damage and non-combatant casualties. A tactical mistake can have a significant strategic impact. We already operate in an environment where "precise" does not mean what it once did. Hitting the right building used to be enough. We now have to hit the right person. CAS platforms also must be prepared to operate in megacities, an environment where bombs and explosive strafe rounds may be prohibitively destructive. Large buildings complicate tracking and targeting in the urban environment. Thus, the ability to provide support and situational awareness to ground forces in cities is significantly challenged.[41]

No legacy aircraft is suited to provide CAS in a contested environment that features widespread surface and air threats. Although current 5^{th} generation fighters can survive in high threat environments, they cannot get the job done alone. However, this technology is central to the future of CAS, but not as a replacement for the current 4^{th} generation CAS platform. Instead, it must be part of a system-wide transformation of the way that we do CAS.

Future CAS missions will build on the tremendous capabilities of the aircraft as a sensor integrator, and develop the platform as a battle manager of unmanned surveillance and attack platforms. Current 5^{th} generation fighter technology is uniquely adapted to these tasks where the

fighter operates in concert with manned and unmanned systems to provide close air support on the modern battlefield.[42] Network Enabled Capability weapons will be used in time sensitive precise targeting. These laser guided (imaging), rocket assisted, variable yield weapons will be able to strike small and unpredictable moving targets while the pilot has the ability to control weapon effect through the time of flight till impact.[43]

Evolution in Interdiction

Today, the global precision strike discipline considers air, space, and cyberspace as an integrated operational environment. Capabilities from these domains can contribute to precision effects in and across all five domains of the enemy's centers of gravity, i.e., leadership, system essentials, infrastructure, population and fielded military.[44] In order to maximize operational agility against advanced adversaries, most strike missions include closely integrated operations and effects in more than one domain. Precision strike effects are well-timed, synchronized, immediately assessable, and scalable to minimize provocation and avoid unintentional escalation. Airmen collaborate with joint and coalition counterparts and with networked experts worldwide to synthesize combinations of kinetic/non-kinetic, lethal/non-lethal, direct/indirect, and permanent/reversible effects, striking targets in hours, minutes—or seconds. In the air domain, high-end manned and uninhabited precision strike assets are low-observable and have long range, high endurance, and mission-configurable payloads.[45]

Evolution in Cyberspace and Cyber warfare

In 2035, cyberspace capabilities are seamlessly integrated into global precision strike operations, giving decision makers an agile suite of kinetic and non-kinetic options to produce

precise, predictable effects. Cyberspace effects can be delivered from a wide array of Air Force platforms. They can be temporary and reversible, or they may create significant, lasting effects. A precision strike in cyberspace may preclude kinetic operations, it may be a vital enabler for ongoing or follow-on activities (to include deceiving adversaries as to the location or intent of joint forces), or it may deliver the ultimate, decisive stroke of a complex multi-domain operation.[46] In the war of 2035, a next generation fighter could use its radar-enabled offensive cyber weapons to win without firing any missiles.[47] Furthermore, its own sensors could be used in the cyber and Electronic Attack (EA) role as well.

Evolution of unmanned aerial systems (UAS)

Current UAVs are suited only for ISR and light strike operations in relatively permissive environments and not for full spectrum warfare in denied environments. Today, any air threat can all but nullify the use of unmanned aircraft over any battlefield. Certainly, efforts have already been initiated to develop and build the next-generation of unmanned aircraft that can operate in denied environments, such as the United States' Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) program. However, such vehicles are still likely to face the same political challenges to their use as do today's generation of UAVs.[48] However, in the future, the contribution of a drone should not be seen in isolation, but rather, as part of system-of-systems. The next generation fighter will be envisioned as the centerpiece of a networked system of systems that orchestrates unmanned aerial assets as part of a chain of capabilities between the seer and shooter. Here, the drone can be used as an adversary detonator, carrier of extra payload or additional sensor in a contested environment.[49]

The combat cloud

The term Combat Cloud describes the universe of information that could be available from sensors that today are largely "stove piped" and require time-consuming and error-prone human intervention to share what they collect. Data floods in from fifth generation warplanes, satellites, ISR aircraft, both manned and unmanned, plus from cyber and other sources on the ground. The goal of Fusion Warfare is to produce a comprehensive picture of the battle space in real time so battle space managers can stay inside any adversary's OODA Loop (an acronym for Observe, Orient, Decide, Act).[50] The combat cloud involves joint networking, making each warfighter both participant and consumer of the ISR mission. The combat cloud, a constantly evolving endeavor, will eventually give commanders at all levels unprecedented amounts of tailored information to aid decision making.[51] The future operating environment will be increasingly complex, with high volumes of rapidly produced data moving along contested lines of communication to challenge the decision capacity. A fifth generation fighter will be a significant contributor to the combat cloud and the optimal platform with the unprecedented ability to access data. The concept is designed to be used in an integrated system and will change how air forces interact with Navy and Army as well as with other allies. [52]

Stealth Technology

Non-stealthy aircraft are becoming more vulnerable to being shot down by modern integrated air defense systems; therefore, stealth is the foundation for survivability and lethality.[53] It allows aircraft to operate in contested areas, including anti-access/area denial environments that legacy fighters simply cannot penetrate or evade. Advanced stealth technology is "the price of admission" into modern warfare.[54] However, creating a stealth-capable fighter

requires striking the right balance between stealth, maneuverability and affordability. A stealthy aircraft with regard to a sensor pack requires a comprehensive approach and attention in the domain of radar cross section, IR signature, visible appearance, acoustic stealth and signal emission. States with advanced defense networks could develop traditional and non-traditional means to detect and engage air dominance platforms entering their battle space. States possessing traditional, mono-static air defense networks may obtain more advanced air defense systems (e.g. SA-20's) to significantly improve their air defense capabilities. Such systems, with engagement ranges exceeding 100 nautical miles and advanced radar processing technology put current combat aircraft at risk. Advanced states may pursue more advanced means, such as bi- static radars, to improve their capabilities. Bi-static is the term used to describe the orientation of the radar system in which the transmitting and receiving antennas are physically separated. Therefore, US stealth platforms may find themselves unexpectedly vulnerable in this new battle space. New systems to target low observable combat platforms are designed from the outset for sensor fusion - when different sensors detect and track the same target, the track and identification data are merged automatically. This is intended to overcome a critical problem in engaging stealth targets: Even if the target is detected, the "kill chain" by which a target is tracked, identified and engaged by a weapon can still be broken if any sensor in the chain cannot pick the target up.[55] As software and processing technology continue to improve, bi-static radar systems could quickly render current stealth technology obsolete. However, bi-static configurations with advanced signal processing capability, could "exploit radio signals already plentiful in the atmosphere rather than generating its own target beams." This leads to the next hurdle in future air dominance: completing mission objectives in hyper-defended airspace. In response, the combat aircraft or other combat platforms may need to use cyber-attack against signals

processing centers to support air operations.[56] Finally, to indicate the importance and future of low observable aircraft, world powers like China and Russia are also building stealthy aircraft which indicates the universal understating of the advantages of stealth technology.

Notes

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